PROCEEDINGS
OF THE
WASHINGTON ACADEMY OF SCIENCES
VOL. XIII, NO. 3, PP. 51–65. AUGUST 15, 1911

REMARKS ON THE FOSSIL TURTLES ACCREDITED TO THE JUDITH RIVER FORMATION.[1]

BY F. H. KNOWLTON.

In my paper entitled The Stratigraphic Relations and Paleontology of the 'Hell Creek beds,' 'Ceratops beds' and their equivalents, and their reference to the Fort Union Formation,[2] I made, among others, the following statements regarding the turtles of the Judith River formation: "It has recently been confidently asserted on eminent authority that the turtles of the 'Ceratops beds' are very closely related to those of the Judith River formation; in fact that several species are identical, and others so close as to be separated with difficulty. Fortunately the work of Hatcher, published as late as 1905, has left us with a very complete annotated list of the Judith River forms, which makes a valuable basis of comparison of the two faunas. It needs, however, but a cursory examination to show that at least half of the species listed as belonging to the Judith River do not belong to this fauna at all, but come from the Fort Union, Arapahoe, etc., or are so fragmentary as to be unidentifiable. . . . Any comparison of the turtles of the Judith River formation with those of the 'Ceratops beds' as tending to support the Cretaceous age of the latter, does not make a very impressive case."

[1] Published with the permission of the Director of the United States Geological Survey.

[2] Wash. Acad. Sci., Proc., vol. xi, 1909, pp. 235, 236.

Lack of space at that time precluded the full presentation of the data on which the above statements were based. Inasmuch as this mild remonstrance does not appear to have attracted attention, and since the turtles are still being used to "prove" close relationship between the Judith River and Lance ("Ceratops beds") formations, it seems opportune to set forth the facts as they are. In a paper[3] just published Dr. O. P. Hay writes as follows: "My study of the fossil turtles indicates that the species of these animals rarely pass from one epoch to another. If they have ever done so they passed from the Judith River into the Lance Creek epoch. There are five or six species of Judith River turtles which are represented in the Lance Creek and Hell Creek beds by turtles of identical or very closely related species."

In the following pages it is proposed first to take up the species of turtles mentioned by Hatcher[4] as belonging to the Judith River formation, and to indicate the type locality for each species as well as its subsequent distribution so far as this is a matter of published record. Later in this paper the species enumerated by Doctor Hay will be similarly treated, and finally some remarks will be presented on the results of this showing.

Turtles of the Judith River Formation Enumerated by Hatcher.

1. Trionyx foveatus Leidy [Aspideretes foveatus (Leidy) Hay].

Type locality: "Bad Lands of the Judith River, Nebraska Territory." Fragments collected by Doctor Hayden and named and described by Doctor Leidy in 1856[5]. Subsequently Leidy figured two of the type specimens, together with another specimen, identified doubtfully as the same species, from Long Lake below old Fort Clark on the Missouri River, North Dakota, the latter belonging to the Lance formation. On this point Hatcher says: "Considering the difference in the age of these deposits, it is quite

[3] Where do the Lance Creek ("Ceratops") Beds belong, in the Cretaceous or in the Tertiary? Indiana Acad. Sci., Proc., 1909 (issued Oct. 1910), p. 21 (of reprint).

[4] U. S. Geol. Surv., Bull. 257, 1905, pp. 72–80.

[5] Acad. Nat. Sci., Phila., Proc., vol. viii, 1856, p. 73.

probable that had better material been at the disposal of Doctor Leidy he would have found them to be at least specifically distinct." Specimens identified by Cope as *Trionyx foveatus* were collected by Sternberg in the Judith River area in 1876; it does not appear to have been found by Stanton and Hatcher when they visited the area in 1905. This species was reported by Marsh from the "Ceratops beds" near Denver, Colorado, but according to Hay these specimens "belong probably to *Aspideretes beecheri*" a species from the Lance formation of Converse County, Wyoming. *Trionyx foveatus* has also been identified by Lambe from the Belly River beds of the Red Deer River region in Canada, and by Barnum Brown in the "Hell Creek beds" (= Lance formation) of Montana.

From this review it appears possible that there are two and quite likely three species confused under the name of *Trionyx foveatus*, and hence any conclusion as to which part of the "species" belongs to the Judith River, and which to the Lance formation, must be a matter of more or less doubt.

2. Trionyx vagans Cope [Aspideretes? vagans (Cope) Hay].

Type locality: Bijou Basin (Bijou Creek), 40 miles east of Denver, Colorado, in beds regarded by Cross as probably Arapahoe in age. It was also reported by Cope from near the mouth of the Bighorn River, Montana, and near Long Lake, North Dakota, both localities in beds belonging in all probability to the Lance formation. Apparently on the basis of Lambe's reporting it from the Belly River beds of the Red Deer River in Canada, it was included by Hatcher in his list of Judith River species, though Hatcher himself points out the obvious distinctness between the type specimens and the specimens so identified by Lambe. Hay has referred Lambe's specimens to another species, and hence all pretense of *Trionyx vagans* as a Judith River species disappears.

3. Plastomenus coalescens Cope. [Aspideretes coalescens (Cope) Hay].

Type locality: "Bad Lands south of Woody Mountain, latitude 49°," longitude about 106°, Assiniboia, Canada.

Much confusion has arisen concerning this species, which can only be eliminated by a review of all the earlier references to it in the literature of the subject. It was first mentioned but without description in a list published by Cope in 1875,[6] and was fully described later in the same year in an obscure paper published as an appendix to Dawson's Report on the Geology and Resources of the Region in the vicinity of the Forty-ninth Parallel, etc.[7] Still later in 1875 this description was copied word for word, but without reference to either of the two preceding places of publication in Cope's Vertebrata of the Cretaceous Formations of the West.[8] In the Report where it was first described the locality was given as The Bad Lands south of Woody Mountain, latitude 49°, a locality confirmed by Dawson in his description of the geology of the region.[9] Dawson also mentions other vertebrate remains with which it was found associated, as well as several species of plants, and refers the beds to the "Lignite Tertiary," and in the latest published geological map of Canada,[10] the area is still colored as "Laramie," which in the writer's opinion is the approximate equivalent of the Fort Union of the United States.

The confusion dates from the moment when Cope transferred the original description to his "Vertebrata of the Cretaceous Formations of the West," where as regards the locality he says: "This species is found . . . . near the Milk River in British America," where it was "collected by George M. Dawson . . . . near Woody Mount." As a matter of fact Woody Mountain (or Woody Mount) is *more than 150 miles east* of the valley of Milk River where it crosses the international boundary, and there is not the slightest evidence that it came from Milk River. But because it was supposed by subsequent writers that Woody Mountain was in the Milk River Valley, it was assumed that the age must be Judith River! Thus Hatcher,[11] who was apparently in ignorance of the original place of publication says: "This species is founded on fragments . . . .

[6] Acad. Nat. Sci., Phila., Proc., 1875, p. 9.
[7] Brit. N. A. Bound. Com., Montreal, 1875. Appendix B, p. 337.
[8] Rept. U. S. Geol. Surv. Terr., vol. 2, 1875, p. 92.
[9] Brit. N. A. Bound. Com., Montreal, 1875, p. 105.
[10] Western Sheet, 1901.
[11] U. S. Geol. Surv., Bull. 257, p. 74.

collected by George M. Dawson near Milk River in Canada, from beds referred by Cope to the 'Transition series, probably the Fort Union or Lignite epoch,' but now known to belong to the Judith River." This error is also perpetuated by Hay in his Fossil Turtles of North America,[12] who, although obviously familiar with the original place of publication, still gives the locality as "in the basin of Milk River, south of Wood Mountain, Assiniboia, British Columbia."

The above exposition would seem effectively to dispose of the claim for Judith River age of the type material of *Plastomenus coalescens*, though it might possibly be considered to figure as a Judith River species if Doctor Hay's reference to it of a specimen identified by Lambe as *Trionyx vagans* is of valid standing. That is to say Lambe collected a large, finely preserved specimen, which he identified as Cope's *Trionyx vagans*, in the Belly River deposits in the region of the Red Deer River, below Berry Creek, in Alberta. Concerning this Doctor Hay says:[13] "The present writer, regarding Cope's type of *Trionyx vagans* as too small and imperfect a fragment for satisfactory comparison with materials from any region, except the type locality in Eastern Colorado, is compelled to seek for some more probable disposition of Mr. Lambe's fine specimen. Since the plastron of Cope's *Plastomenus coalescens* indicates a large trionychid which lived in approximately the same region and in the same geological period, it appears to be best to refer the Red Deer River carapace to the same species." It appears, then, that the study of these specimens themselves is not sufficient to determine whether Lambe's specimen is really referable to Cope's species, so the burden is placed on stratigraphy!

4. Plastomenus costatus Cope.

Type locality: "Bad Lands south of Woody Mountain, latitude 49°."

This species was found in the same locality and horizon as the last, and the same confusion and compounding of error has resulted. Simply because Woody Mountain was supposed to be in the valley

[12] 1908, p. 489.
[13] Op. cit., p. 489.

of Milk River it followed that the age must be Judith River! Upon this assumption alone rests the claim.

This species has been found by Barnum Brown in the Lance formation ("Hell Creek beds") 12 miles south of the Missouri River, on Hell Creek, Montana. This locality is about 100 miles directly south of the type locality in Canada.

5. Plastomenus punctulatus Cope.

Type locality: Bijou Creek, 40 miles east of Denver, Colorado, in beds that are of Arapahoe age according to Whitman Cross. Cope also states that he had the same species from beds at Long Lake, "Nebraska" (now North Dakota), the age of which is Lance formation.

Hatcher's reason for including this species in the Judith River fauna is interesting. He quotes[14] Cope's statement, evidently from his Vertebrata of the Cretaceous Formations of the West, to the effect that it was "found in association with the preceding species," which, in this book happens to be *Plastomenus costatus*, but in the place where *P. punctulatus* was originally described,[15] the "preceding species" happens to be *Trionyx vagans*, the status of which has already been considered above. As the original description was transcribed without change from the Annual Report into the Monograph the error arose as stated above and as has been pointed out by Doctor Hay. *Plastomenus punctulatus* can, therefore, lay no claim to having been found in the Judith River.

6. Plastomenus insignis Cope.

Type locality: Bijou Creek, 40 miles east of Denver, Colorado.

This species was introduced into the Judith River fauna by Hatcher[16] who, consulting Cope's Vertebrata only, and ignoring the original place of publication, concludes that by "inference" it came from south of Woody Mountain, and if from this locality it was assumed, as in the cases of the several species above considered, that

[14] U. S. Geol. Surv., Bull. 257, p. 74.
[15] U. S. Geol. and Geogr. Surv. Terr., Ann. Rept., 1873 (1874), p. 453.
[16] U. S. Geol. Surv., Bull. 257, p. 75.

it must be of Judith River age. It is clear enough when the original description is consulted that this species came only from Bijou Creek, Colorado, and this is confirmed by Doctor Hay who has examined the type now in the American Museum of Natural History and finds it labeled in Cope's handwriting as "*Plastomenus insignis*. 10–9–1873, Colorado." It is therefore to be excluded from the Judith River fauna, but not for the reasons given by Hatcher.

7. Adocus lineolatus Cope.

Type locality: Bijou Creek, 40 miles east of Denver, Colorado, in beds believed to be Arapahoe in age. Also reported by Cope from the mouth of the Bighorn River, Montana, and it appears in his list of Judith River vertebrates, though according to Hatcher this last reference is probably "due to an oversight." Fragments that have been identified as this species have been found by Lambe in Belly River beds of Red Deer River, Alberta, by Barnum Brown in the Lance formation on Hell Creek, Montana, and by others in the "Ceratops beds" (Lance formation) of Converse County, Wyoming. Hatcher has expressed as his opinion[17] that the reference of Lambe's specimens "may be incorrect" and Doctor Hay[18] says: "It is the writer's opinion that it is unsafe to identify as belonging to *Adocus lineolatus* specimens from the Judith River and Laramie beds before far better materials of the species have been collected from the type locality." He adds: "It is improbable that the same species continued from the Judith River epoch to the Arapahoe epoch," which latter, be it remembered, is the probable age of the type material.

8. Basilemys ogmius (Cope).
Basilemys variolosa (Cope).

Type locality: "From six miles west of the first branch of Milk River, near latitude 49°," in the province of Alberta, British America. Because this locality is in the vicinity of Milk River it has been assumed by Hatcher and others that the age must be Judith River,

[17] U. S. Geol. Surv., Bull. 257, p. 76.
[18] Fossil Turtles of North America, p. 248.

but a careful reading of Dawson's account[19] of the geology of the place where he actually obtained the specimens shows that in all reasonable probability it should be referred to the "Ceratops beds," that is the Lance formation. Dawson considered the beds as "belonging probably to the base of the Lignite Tertiary," and compares them to the beds south of Woody Mountain, adding: "The bones, in the manner of their preservation, much resemble division β of the Bad Lands south of Woody Mountain, which these beds may possibly represent." The lithology is described as similar in the two areas, and associated with the remains of the turtles Dawson reports finding many bones of dinosaurs, and large Unio shells. In any event it seems unsafe to refer these beds to the Judith River merely on geographical position and without corroborative data.

The type specimens of *Basilemys ogmius* are said to be very poor, and Doctor Hay states that: "It is doubtful whether new materials could be identified by means of the type." However this may be, this species has been combined with *Basilemys variolosa* (Cope), which has as its type locality "Bad Lands of the Judith, Montana," and was described a year or more later. Material that has been identified as *Basilemys* (or *Adocus*) *variolosa* has been mentioned by Lambe from the Belly River beds of Red Deer River, Alberta, and by Hatcher in the Judith River formation of Montana. It seems not improbable that there may be two species represented, but in any event it would appear that the undoubted Judith River material has been that identified with "*B. variolosa*," whereas the *B. ogmius*, being very poor, has not been certainly recognized.

The conclusion reached is that that part of the "species" named "*B. ogmius*" came from beds that are not certainly of Judith River age, and has not been subsequently recognized, while the part known as "*B. variolosa*" came from beds of Judith River age, and is the only part of the "species" that has been distinguished by later authors.

9. Basilemys imbricarius (Cope).

Type locality: Judith River Basin, Montana, in beds of the Judith River formation; it has not been found elsewhere. It was founded on very unsatisfactory materials, according to Doctor Hay.

[19] Brit. N. A. Boundary Com., 1875, p. 130 *et seq.*

10. Polythorax missouriensis Cope.

Type locality: Judith River Basin, Montana, in beds of the Judith River formation. It has not been reported from any other locality or horizon.

11. Baëna antiqua Lambe.

Type locality: Red Deer River, Alberta, British America, in beds supposed to be of Belly River age; it has not been obtained elsewhere.

12. Baëna hatcheri Hay.

Type locality: South side of Lance Creek, opposite mouth of Dogie Creek, Converse County, Wyoming, in beds of the Lance formation ("Ceratops beds").

A specimen from the Belly River beds of the Red Deer River, Alberta, was referred to this species by Lambe,[20] and it was upon this ground that it was included by Hatcher[21] in the Judith River fauna. Later, however, Doctor Hay[22] referred Lambe's specimen to a totally different genus and species (*Boremys pulchra*), and hence *Baëna hatcheri* is to be eliminated from the Judith River fauna.

13. Neurankylus eximius Lambe.

Type locality: Red Deer River, Alberta, British America, in beds regarded as of Belly River age; it is monotypic and has not been collected elsewhere.

There is one naïve bit of history connected with this genus that should not be omitted. Doctor Hay in his Fossil Turtles of North America (p. 93) remarks as follows: "Mr. Lambe placed the genus provisionally among the Chelydridae, but as no genera of this family are known from deposits older than the Tertiary and as the type has some resemblance to the Baënidae, which flourish at that time, it seems better to refer Neurankylus to this family until more is known about it."

[20] Cont. Canadian Pal., vol. 3, 1902, pt. ii, p. 43.
[21] U. S. Geol. Surv., Bull. 257, p. 79.
[22] Fossil Turtles of North America, 1908, p. 92.

Turtles Mentioned by Hay as Tending to Show Identity or Close Similarity Between Species of the Judith River and Lance Formations.

Following is the list of six species given by Doctor Hay[23] and of which he says: "I shall take pains to give some details."

1. Compsemys obscura (Leidy).

Type locality: Near Long Lake, on the Missouri River below Fort Clark, North Dakota, in beds regarded as belonging to the Lance formation. It has otherwise been collected only in beds of the Lance formation ("Hell Creek beds") on Hell Creek, Montana.

This species was included by Cope[24] in his list of Judith River vertebrates, but without giving any evidence in support of such reference, and presumably on the authority of Cope's list it is included by Osborn[25] in his list showing the "distribution of the land and fresh-water Cretaceous vertebrates in the west," as occurring in Montana and hence "by inference" in the Judith River fauna. *Compsemys obscura* as well as its companion species, *C. victa*, was excluded from the Judith River fauna by Hatcher, who says, "In no descriptions of either of these species can I find any suggestion that remains of either have been described from Montana." That *C. obscura* is properly excluded from the Judith River is shown by Doctor Hay, who says,[26] "This species is included by Cope in his list of Judith River fossils, but the writer knows of no specimens that confirm the statement." Curiously enough, however, this species is the first one given by Doctor Hay[27] as occurring in both Judith River and Lance formations!

2. Compsemys victa Leidy.

Type locality: Long Lake, on the Missouri River below Fort Clark, North Dakota, in beds regarded as belonging to the Lance formation, that is the same locality and formation as the last.

[23] Proc. Indiana Acad. Sci., 1909, p. (of reprint) 21.
[24] U. S. Geol. and Geogr. Surv. Terr., Bull. vol. 3, 187, p. 573.
[25] Cont. Canadian Paleont., vol. 3, 1902, pt. ii, p. 12.
[26] Fossil Turtles of North America, 1908, p. 236.
[27] Proc. Indiana Acad. Sci., 1909, p. (of reprint) 21.

The history of this species is much the same as that of the last, except that specimens identified under this name have a somewhat wider distribution. It was included by Cope in his list of Judith River vertebrates, but, as stated under the last species, was excluded from this fauna by Hatcher. It is accepted by Doctor Hay[28] as of Judith River age on the ground that it was found in the region about Milk River, Alberta. This occurrence in the "Milk River region" is traceable to Dawson's Report on the Geology and Resources in the Vicinity of the Forty-ninth Parallel, but, as in the case of *Plastomenus coalescens*, a reading of the geological part of the report shows that it came from south of Woody Mountain, and 150 miles east of the Valley of Milk River, in beds of "Lignite Tertiary" age.

This species was reported by Cope from supposed Arapahoe deposits east of Denver, Colorado, and is said to be "very common in the Lance Creek beds," of Converse County, Wyoming. It was also found by Brown in the Lance formation ("Hell Creek beds") on Hell Creek, Montana, and an allied but undescribed species is reported by Doctor Hay from the Fort Union.

From this brief exposition it is clear that *Compsemys victa* must be excluded from the Judith River fauna, and the only horizons in which it is authenticated are Arapahoe and Lance formations. In the treatment of this species in his Fossil Turtles of North America (p. 234), Doctor Hay opines that there is so much difference in age between Judith River, Arapahoe and Denver, and Lance formations that it is "not improbable" that three species are represented instead of one. Again would the responsibility be shifted from paleontology to stratigraphy!

3. Aspideretes foveatus (Leidy) Hay.

The status of this species has been already considered under its synonym, *Trionyx foveatus*, ante, p. 52.

4. Aspideretes beecheri Hay.

Type locality: East side of Lance Creek, Converse County, Wyoming, in beds belonging to the Lance formation. Two cara-

[28] Fossil Turtles of North America, p. 234.

paces from the Judith River of Fish Creek, Montana, have been referred to this species by Doctor Hay, who makes the following statement concerning them: "No characters are observed which serve to distinguish these carapaces from that of the type of *A. beecheri*. It is not improbable, however, that they belong to a distinct species."

5. Adocus lineolatus Cope.

The status of this species has been considered, ante, p. 57.

6. Basilemys variolosa (Cope).

This has already been considered at length under its synonym *Basilemys ogmius*, p. 57.

Discussion of Evidence Regarding "Judith River" Turtles as Brought out in the Foregoing Review.

On combining the lists given by Hatcher and Hay it appears that sixteen species of turtles have been accredited to the Judith River formation. Of these sixteen species it has been demonstrated that only three species have the type specimens from the original Judith River area in Montana, while two additional species have the types from the Belly River (= Judith River?) of the Red Deer River region of Alberta. The three species from Montana are the following:

Trionyx foveatus
Basilemys imbricarius
Polythorax missouriensis

The two Canadian species are:

Baëna antiqua
Neurankylus eximius

Of the remaining species four, as follows, have the types described from Bijou Creek, Colorado, in beds supposed to be of Arapahoe age:

Trionyx vagans
Plastomenus punctulatus
Plastomenu sinsignis
Adocus lineolatus

The types of two species came from south of Woody Mountain, Assiniboia, in beds referred to the "Lignite Tertiary" by Dawson, Cope, and others, but are now considered to belong to the Lance formation. They are:

Plastomenus coalescens
Plastomenus costatus

From Long Lake, North Dakota, in beds of the Lance formation, the following types are supplied:

Compsemys obscura
Compsemys victa

The types of two species were obtained from the Lance formation of Converse County, Wyoming:

Baëna hatcheri
Aspideretes beecheri

The remaining species is *Basilemys ogmius* which as already shown is of mixed position. Strictly speaking the type came from near Milk River, Alberta, in beds that are probably younger than the Judith River, while *B. variolosa*, the "species" with which it has been combined, came from the Judith River formation near Judith River, Montana.

A further analysis of the evidence adduced indicates that the following species should be excluded from the Judith River fauna on the sufficient ground that they do not occur in beds of this age:

Trionyx vagans
Plastomenus costatus
Plastomenus punctulatus
Plastomenus insignis
Baëna hatcheri
Compsemys obscura
Compsemys victa

To return again to the five species having their type locality in Judith River and Belly River beds, it appears that the four following have never been found outside the Judith River or Belly River horizons.

Basilemys imbricarius
Polythorax missouriensis
Baëna antiqua
Neurankylus eximius

The fifth species—*Trionyx foveatus*—is the only one that appears to be distributed into higher beds, but it will be recalled on referring to the discussion of this species on page 53, that, while it has been reported from Long Lake, North Dakota, Hell Creek, Montana, and near Denver, Colorado, both Hatcher and Hay have expressed the opinion that there may be two and possibly three species confused under this name, each being confined to one of the three horizons involved.

The following forms, although having their types from beds higher than the Judith River formation (Arapahoe, Lance formation etc.), appear on more or less questionable evidence to have ranged downward into the Judith River:

Plastomenus coalescens (*?*)
Adocus lineolatus (*?*)
Aspideretes beecheri (*?*)

The reasons why these are regarded as questionably present in the Judith River formation are set forth in the discussions of these species in the preceding pages. Not a single one has a clear title.

Conclusions.

1. The Judith River fauna has had accredited to it by Hatcher and Hay at least sixteen species of fossil turtles.

2. Of these sixteen species seven are to be excluded on the sufficient ground that they do not occur in beds of Judith River age.

3. Of the nine remaining species that may have a more or less valid claim to membership in the Judith River fauna, five have their type localities in beds of Judith River and Belly River age, and four in horizons above that of the Judith River.

4. Of the five typically Judith River species, four are absolutely confined to these beds, while the remaining one which has an alleged higher range, is shown to be probably a composite species possibly including three species which correspond respectively to the three horizons involved.

5. Of the four species, the types of which came from post-Judith River beds, and which are claimed to range downward into the Judith River, not a single one enjoys a clear title to be so regarded.

6. It is plain, then, that the comparisons that have been made between "Judith River" turtles and those of higher horizons (Lance formation, "Laramie," "Ceratops beds," "Hell Creek beds," "somber beds," etc.), have not been made with species that really belong to the Judith River fauna, but with forms that actually belong to these higher beds. It is not to be wondered at that such a comparison has resulted in showing "identity" and "striking similarity," since it is in accord with the ancient axiom, that "Things equal to the same thing are equal to each other."

PROCEEDINGS
OF THE
WASHINGTON ACADEMY OF SCIENCES
VOL. XIII, No. 4, PP. 67–84 Pl. vi NOVEMBER 15, 1911

ON THE SYSTEMATIC VALUE OF RANA CHINENSIS OSBECK.

BY DR. STEFAN BOLKAY.

In an article which I published in "Âllattani Kozlemények (3)", I separated as a distinct species *Rana ridibunda* from *Rana esculenta*. After the publication of that paper Professor Dr. Méhely directed my attention to a frog found in China and Japan which is mentioned in literature, according to Boulenger, as a variety of *R. esculenta* (*Rana esculenta chinensis* Osb.), but which, however, as Professor Méhely observed, can be separated with more right from *R. esculenta* than is *R. ridibunda*.

A short time afterward my article appeared in German also (4), and was commended by Wolterstorff who wrote as follows on that subject: "As soon as we acknowledge the right of a species for *Rana ridibunda* we must do the same with more reason still for *Rana chinensis*, a fact also recognized not long ago by Stejneger."

Wolterstorff considers this same question in one of his articles, published in 1906, and there expresses his conviction that *Rana chinensis* is a well-defined subspecies.

Quite recently Leonhard Stejneger, the American herpetologist, described *Rana chinensis* as a distinct species under the name *Rana nigromaculata* Hallowell.

The first author who describes *Rana chinensis* is Osbeck. He mentions as the sole peculiarity distinguishing it from *R. esculenta* the fact of its having six toes of which the sixth is the shortest.

Schlegel finds it quite similar to *R. esculenta*. Maack alludes to it as *R. esculenta var. japonica* Hallowell and describes it under the two names *R. marmorata* and *R. nigromaculata*. Peters and Cope go furthest, placing it in an other genus, the former mentioning

it as *Hoplobatrachus reinhardti*, the latter under the name *Tomopterus porosa*. Lataste calls it *R. esculenta marmorata*. Boulenger refers to it at first as *R. esculenta var. japonica*, then as *var. nigromaculata*, and quite lately as *var. chinensis* Osbeck.

R. chinensis has been mentioned only once in Hungarian literature, Professor von Méhely describing as *R. esculenta var. chinensis* the three specimens collected at Peking by the Zichy expedition.

The great confusion existing in literature upon that question, as well as the statements by Professor von Méhely and Professor Wolterstorff, induced me to study the Chinese frog. My aim is to point out, with especial regard to the osteological marks, the systematic position of *R. chinensis*, and to prove at last that the Chinese frog has nothing to do with *R. esculenta*, and that taking all of its characteristic features into consideration, it can be placed near to *R. ridibunda* Pallas.

I find it necessary to give a detailed description of the species, improved and completed by the result of recent observations made upon specimens from the Hungarian National Museum as well as upon others from China bought at Magdeburg from Wolterstorff. Having pursued my investigations in the Hungarian National Museum, I wish here to express particular thanks to Professor von Méhely for the kind assistance he lent me in my work, allowing me the benefit of the Museum's material as well as giving me most valuable information.

RANA CHINENSIS Osbeck.

Synonymy.[1]

1765. *Rana chinensis* Osbeck, Reise Ostind. China, I, (p. 244); Voy. China (Engl. ed.), I, 1771, p. 299 (Canton, China).

1906. *Rana esculenta* subsp. *chinensis* Wolterstorff, Abhdl. Berichte d. Mus. f. Natur. und Heimatkunde zu Magdeburg, Bd. I, Heft 3, 1906, pp. 135–143.

1907. *Rana nigromaculata*, Stejneger, Herpetology of Japan and adjacent Territory, Bull. U. S. Nat. Mus. No. 58, p. 94, pl. 10, fig. 1.

[1] For complete Synonymy see Stejneger, Herpetology of Japan, cited above.

Description.

Vomerine teeth in two slightly oblique groups between the choanæ very seldom extending to the line joining the posterior border of the choanæ. The male's head is generally narrower, that of the female rather broader than its length. The snout is pointed and projects beyond the mouth; the distance from the anterior corner of the eye is always longer than the eye's horizontal diameter; *canthus rostralis* strongly marked; loreal region slanting, rather sunken; nostrils considerably nearer to the eyes than to the tip of the snout; interorbital space contained about one and a half times in that between the nostrils and about twice in the breadth of the upper eyelid; (these measurements are subject to slight variations.) Tympanum well developed, its horizontal diameter longer than the vertical, equal to two-thirds, at most, to three-quarters of the diameter of the eye.

The fingers of the fore limbs are rather pointed, the first longer than the second; the subarticular tubercles are prominent, and well developed.

The hind limbs being carried forward along side of the body the tibio-tarsal joint reaches the posterior corner of the eye, or at most to between the anterior corner of the eye and the nostril; tibia always much shorter than the fore limb, or the foot measured from the outer meta-tarsal tubercle; when the hind limbs are bent at right angles to axis of body, heels never do meet; toes entirely webbed; the subarticular tubercles small and not very prominent; the inner meta-tarsal tubercle (Plate VI, fig. 1) very large, projecting, compressed, on both sides, hard and sharp, twice as long as high; its length contained 1–1.8 times in length of inner toe and 4.8–7.5 times in that of the tibia; it is most characteristic, that the inner meta-tarsal tubercle is never parallel with the length-axis of the sole but invariably forms a greater or smaller angle with it. It is very characteristic, further, that the inner meta-tarsal tubercle never adheres to the base of the thumb but is attached to it in a mobile way with a web, spreading between it and the thumb. At the root of the fourth (longest) finger there is always a small, roundish outer meta-tarsal tubercle.

The glandular lateral folds are well developed, their width being at least equal to one-third of an upper eyelid, not seldom, however, attaining the entire breadth of it; the distance between the lateral folds,—measured on the scapular region,—is contained $4\frac{1}{4}$–$5\frac{1}{2}$ times in whole length of head and body.

On the back, on both sides of dorsal line, longitudinal dorsal folds, which vary in length but are always sharply projecting; these are generally disposed in six longitudinal rows, on the anterior part of the back, and in eight on the posterior part of it; breadth of one fold amounts to about half of inter-orbital space, greatest length, to twice the length of the upper eyelid, frequently, however, equal to $4\frac{1}{3}$. The back of one of the specimens found at Pingshiang, besides the usual folds, is covered with innumerable small warts, which make it look unusually warty.

Chin, throat and fore part of belly smooth; sides of body and lower hind part of thighs alone somewhat granulated, the hind part of belly crosswise slightly wrinkled.

Color (taken from spirit-specimens): Back brownish olive, sprinkled with black spots; the latter present three main types: either unequally rounded as in our *R. esculenta*, or lengthwise extended (specimens from Japan) or again are they of such a shape as we never meet with in our *R. esculenta* viz. in most of the Chinese specimens the black spots widen horizontally.

The vertebral line is pale blue and varies in breadth; the dorso-lateral folds of same color; on the *canthus-rostralis*, beginning at the end of snout, passing across the eye, above the tympanum and at the back of it, runs the black stripe which reaches down behind the angle of the mouth; along the outer side of the dorso-lateral folds, the black spots most frequently melt into a single black stripe; on sides of body large, irregular black spots are to be seen, which often unite into a large black stripe between the articulation of the two extremities; the upper edge of the stripe is undulating and from the lower one, following close upon each other, several branches extend towards the belly. The dark spots on the edge of the upper lip never unite into a single dark stripe.

Upper surface of limbs, tibias, and feet crossed by dark bars. In Japanese specimens we find the dark crossbars of the upper

limbs and tibias invariably detached into blotches.[2] The hind part of the thighs is whitish-grey with dark marblings; belly uniform white, border of lower jaw, however, together with throat region, breast, both sides of belly and thighs, slightly marbled with a darker tint. The vocal sacs are blackish-grey.

Osteological characters. The skull (Plate VI, fig. 2) presents partly the characteristic marks of *esculenta* and partly those of *R. ridibunda*, general form narrow and longish; becoming (gradually) narrower and pointed in front, always narrower than it is long; the *cranium cerebrale* is comparatively higher than in *R. esculenta*. The *pars facialis* of the maxillary much higher than with the *esculenta*. Nasals narrow and meeting at a sharp angle in the middle line, joining each other in a broad ridge, contrarily to the arrangement in *R. esculenta* in which they are broad, meeting at a blunt angle and generally not in contact on the middle line.

The two borders of the fronto-parietals are—in old examples—quite parallel, in younger ones slightly converging forwards; breadth of their inter-orbital space—measured in the middle—is contained 3–3.5 times in its length; posterior border almost straight; upper surface very slightly sunken, *sutura-sagittalis* always entirely ossified.

With *R. esculenta* the fronto-parietals' two outer borders are never parallel, becoming conspicuously narrower towards the front. Their breadth between the orbits, measured in the middle is but 2.5–3 times contained in their length; their back edge is always undulating; their upper surface is deeply sunken; *sutura-sagittalis* open from *os ethmoideum* until about the middle.

Tectum synoticum always triangular, whilst in *R. esculenta* it is invariably quadrangular.

Prooticum always shorter and broader than in *R. esculenta*. The *tympanicum* presents in its formation such differences as separate most markedly the skull of *R. chinensis* from that of *R. esculenta*. The forepart of the *tympanicum*, the zygomatic process, is straight, narrow and long, just reaching the half of the longitudinal diameter of the orbit, sometimes even extending rather beyond it; never curved inwards, being on the contrary, always expanded in front, its

[2] Stejneger (p. 98) mentions specimens from the collection of Dr. Smith and Owston, from Shikoku Islands and Mount Fuji in which the dark blotches on the hind limbs melt into quite distinct crossbars.

Measurements

MEASUREMENTS IN MM.	PEKING		PINGSHIANG				KIUKIANG		JAPAN	
	♂	♀	♂	♀	♂	♀	♀	♀	♂	♀
From snout to vent	66	66	69	69	59	67	90	92	54	52.5
Length of head	22.5	21.5	24.5	23	20.5	22.5	29.5	29	18.5	18.5
Width of head	21.5	22.5	23.5	22	21	22.5	30.5	29.5	17.5	17.5
Diameter of eye	7.5	7	7.5	7.5	7.5	8.5	10.5	10	6.5	7
Interorbital width	3	3	3	2.5	2.5	2.5	4	3.5	2.5	2
From eye to nostril	4.5	5	5	5	4	5	6	6.5	4.5	4.5
From eye to end of snout	10.5	10.5	11.5	10.5	10	10	14	14.5	9	9.5
Diameter of tympanum	.5	4.5	6.5	5	5	5	6.5	6.5	4	4.5
Fore limb	35	33	38.5	35.5	32	36	48	45	29.5	28
Hind limb	101.5	98	106.5	110	91	108.5	138	137	87.5	85
Tibia	29.5	29	30	34	29	32	42	44	25.5	25
Length of foot	36	35	37	36.5	33	38	42	46.5	31	28.5
Inner toe (from tubercle)	6	6	6.5	6.5	7	7	8.5	9	6.5	5.5
Inner metatarsal-tubercle	6	6	5	4.5	4.5	4.5	7	6.5	3.5	3.5

foremost end, consequently, never extending into the orbit. This is also the reason why the posterior corner of the inner branch of *tympanicum* forms a still blunter angle than in *R. esculenta*. The back branch of the *tympanicum* is still shorter than in *R. esculenta*, so that the straight line connecting the articulations of the two jaws invariably crosses the *condylus*. The plate of the inner branch of the *tympanicum* is always shorter than in *R. esculenta*.

The intermaxillary's (fig. 3) inner border never sinks so deep as it does in *R. esculenta*.

The vomerine teeth lie between the *choanæ* in two small, semicircular groups inclining towards each other at a very slight angle; the group of teeth are always separated by a larger space than is the case with *R. esculenta* in which the inner edges of the teeth groups sometimes almost meet—and never attain the straight line connecting the posterior border of the *choanæ*.

The palatines differ from those of *R. esculenta* in as much as they bear on their exterior side a rough, prominent bony crest.

Median branch of *os parabasale* is in general narrower and more rounded than in *R. esculenta*. *Foramen occipitale magnum* in old individuals, oval, in very young ones, round.

If we survey (fig. 4) the skull from the back joining the tympanicum's two posterior corners by a line, it will just about cut across the middle of *foramen magnum*. In *R. esculenta* in 90 per cent of the cases this line touches the upper border of the foramen magnum; with *R. ridibunda* the mentioned line invariably crosses the upper third of the foramen magnum.

The vertebral column (excepting the length of the urostylus) is as long as the skull. Characteristic differences are to be found on the second, third and eighth vertebræ. Whilst, with *R. esculenta* the diapophysis of second vertebra presents a cylindric shape (fig. 5), with only a few unimportant protuberances towards the center of the front border, the diapophysis of second vertebra of *R. chinensis* is flat and presents a well developed bony crest on its anterior border (fig. 6). This bony crest is to be found in *R. ridibunda* also. The outer half of the diapophysis of the third vertebra is carved out, shovel-like (fig. 7). On the median side of its posterior edge a projecting bone ridge extends to the base of the diapophysis. This bone ridge is to be found neither in *R. esculenta* nor in *R. ridibunda*.

The diapophysis of the eighth vertebra (fig. 8) generally curves backwards, median side also expanding wing-like backwards.

It is worth mentioning that the *processi spinosi* of the vertebræ are longer on *R. chinensis* than on either *R. esculenta* or *R. ridibunda*. If we join, by a straight line, the back borders of the *processi obliqui* on the second, third and fourth vertebræ we shall find that the *processi spinosi* invariably extend beyond this line. On *R. esculenta* and *R. ridibunda* the *processi spinosi* generally touch that line, sometimes ending a good deal before it.

The urostylus is as long as the vertebral column.

If we examine the pelvis (fig. 9) so that the symmetric plane passing through the symphysis is parallel with the base we will find the following peculiarities: pelvis 1.2–1.3 times as long as the vertebral column; ilium in its general form straight, the extremities touching the sacral vertebra, being alone slightly curved downwards; upper ridge of the ilium's crest straight and the angle of it which declines towards the acetabulum forms only just a somewhat larger angle than a rectangle. This declining angle is smooth, or presents a hardly visible distended margin; if we draw on the ridge of the ilium crest a line parallel to the base of the *pelvis*, this line will just be reached by the upper corner of the *crista ischio-pubica*.

In *R. esculenta* (fig. 10) the pelvis is 1.06–1.2 times as long as the vertebral column; the ilium is curved, the upper ridge of its crest is rounded and the corner declining towards the acetabulum forms a very blunt angle. This declining corner presents a strongly distended margin and consequently under this margin at the base of the ilium we find a somewhat deep cavity; if we draw on the ridge of the ilium crest, a line parallel to the base of the pelvis, we shall notice that the upper corner of the *crista ischio-pubica* remains far under that line.

The most interesting of the tarsus bones is the so-called præhallux (fig. 11) which is a large, flat spade-like bony plate, growing rather thick towards its base; its outer surface somewhat convex, whilst the inner one is very slightly concave; its greatest breadth equal to two-thirds of its length, the latter to two-thirds to three-fourths of the length of first meta-tarsal bone. In *R. esculenta* the præhallux (fig. 12) is a flat, thin bone plate; greatest breadth half its length, length half that of the first meta-tarsal bone.

In both species we find the præhallux joined to the *tibiale* by an intercalated bone, the *tibiale* being formed by the following principal elements: *tarsale præhallucis, centrale* and *tarsale I.*

Under the second and third meta-tarsal bones we find the *tarsale II.* and *III.;* the fourth and fifth meta-tarsal bones are joined to the fibulare by the so-called *ligamentum tarsi suppleus.*

Measurements of skeleton in mm.

MEASUREMENTS IN MM.	KIUKIANG ♀	PINGSHIANG ♂	PINGSHIANG ♀
Length of skull	28	24	21
Breadth of skull	27.5	21	20
Interorbital space	4	3	3
Columna vertebralis	29	23.5	20.5
Urostylus	29.5	22	20
Humerus	23.5	18	16
Radius-ulna	15	11.5	10.5
Manus	18	15.5	14
Pelvis	38	28.5	26
Femur	38.5	29	31
Tibia	39	29	31
Tarsus	18	14	13.5
Pes	41.5	35	35.5

Rana chinensis **Osb.**	*Rana ridibunda* **Pall.**	*Rana esculenta* **Linn.**
1. Head narrow, long and very pointed at the end.	1. Head broad, short and tip of snout bluntly rounded.	1. Head comparately narrow, tip of snout ending in blunt point.
2. Inter-orbital space equal to half the breadth of upper eye-lid.	2. Inter-orbital space equal to one third the breadth of upper eye-lid.	2. Inter-orbital space equal to half or frequently to three quarters the breadth of upper eye-lid.
3. Heels never meet when hind limbs are bent at right angles to axis of body.	3. Heels always overlap when hind limbs are bent at right angles to axis of body.	3. Heels never meet when hind limbs are bent at right angles to axis of body.
4. Bending the hind limbs forward along the side of body the tibio-tarsal joint reaches the posterior corner of eye or can prolong itself beyond to space between the anterior corner and nostrils.	4. Bending the hind limbs forward along side of body, the tibio-tarsal joint reaches with the female, the back corner of eye, with male the end of snout.	4. Bending the hind limbs forward along side of body the tibio-tarsal joint reaches, on the female the space between the tympanum and posterior corner of eye, on the male,—at the utmost—space between the anterior corner and nostrils.

5. The inner meta-tarsal tubercle is very large, projecting, compressed on both sides, hard and sharp; always a good deal longer than the distance between the subarticular tubercle of first toe and inner meta-tarsal tubercle, frequently equal to length of first toe.	5. Inner meta-tarsal tubercle small, of a flattened cylindrical form not very projecting, always shorter than space between the sub-articular tubercle of first toe and inner meta-tarsal tubercle.	5. Inner meta-tarsal tubercle large, compressed on both sides, projecting; always longer than distance between the subarticular tubercle of first toe and inner meta-tarsal tubercle.
6. The subarticular tubercles on toes of hind limbs small and only slightly projecting.	6. The subarticular tubercles on toes of hind limbs larger and more projecting.	6. The subarticular tubercles on toes of hind limbs are largest and strongly projecting.
7. The vocal sacs are blackish grey.	7. Vocal sacs blackish grey.	7. Vocal sacs milky white.
8. The spaces between the dusky marbling on the back surface of thighs is filled (according to Boulenger) by a yellow color.	8. Spaces between dark marbling on back surface of thighs is never filled with a sulphuric color.	8. Spaces between dark marbling on back surface of thighs always filled with sulphur colored spots.
9. The dark spots of back,—on Chinese specimens—expand horizontally.	9. It is rare that the dark spots of back expand horizontally and that happens only in a small degree.	9. The dark spots on back never expand horizontally.
10. Fold on the back, between the two dorso-lateral folds in 6–8 longitudinal rows, varying in length.	10. No glandular dorsal folds on back.	10. No glandular dorsal folds on back.
11. Skull invariably narrower than long, very pointed at the end.	11. Skull invariably broader than it is long, in front gradually narrowing.	11. Skull generally as broad as long, front part forms a sudden point.
12. Vomerine teeth never meet the line joining posterior border of *choanæ*.	12. Vomerine teeth extend slightly behind the level of *choanæ*.	12. Vomerine teeth generally touch the line joining the posterior border of *choanæ*.
13. The nasals form a sharp angle towards each other and meet in a broad ridge on middle line.	13. The nasals form a rectangle or a somewhat blunt angle and meet in a broad ridge on the middle line.	13. The nasals form a blunt angle and do not meet on the middle line.
14. Side borders of fronto-parietals parallel with upper surface slightly sunken in.	14. Side borders of fronto-parietals converging forwards, upper surface deeply hollowed.	14. Side borders of fronto-parietals converge conspicuously forwards, upper surface deeply hollowed.
15. *Tectum synoticum* triangular.	15. *Tectum synoticum* triangular.	15. *Tectum synoticum* quadrangular.

16. Foramen magnum oval.

17. The *processus zygomaticus* of *tympanicum* expand forwards, just reach to half the length of orbit.

18. Back corner of inner branch of *tympanicum* forms very blunt angle.

19. Back branch of *tympanicum* very short so that the *condylus* always extends beyond line joining the articulation of jaws.

20. If we join by a line the posterior corners of inner branch of *tympanicum*, this line invariably crosses *foramen magnum* in the middle.

21. *Diapophysis* of second vertebra flat, outer side of front border presents a prominent long crest.

22. Outer side of *diapophysis* of third vertebra is carved out shovel-like and on median side of back border a strong, projecting bone ridge extends to the base of the *diapophysis*.

23. *Diapophysis* of eighth vertebra generally curved backwards median side expanding wing-like, backwards.

24. *Processi spinosi* of vertebrae longer.

25. If we draw on pelvis on the upper border of ilium crest a line parallel to base of pelvis, this line will just be attained by upper corner of *crista ischio pubica*.

16. Foramen magnum oval.

17. The *processus zygomaticus* of *tympanicum* curved inwards invariably extends beyond half the length of orbit.

18. Back corner of inner branch of *tympanicum* frequently forms a sharp angle, rather projecting backwards.

19. Back branch of *tympanicum* long, so that the line joining the articulation of jaws remains far behind the *condylus*.

20. If we join by a line the posterior corners of inner branch of *tympanicum* this line generally crosses *foramen magnum* in its upper third.

21. *Diapophysis* of second vertebra cylindrical, outer side of front border presents a slight bony crest.

22. Outer side of *diapophysis* of third vertebra shovel-like carved out.

23. *Diapophysis* of eighth vertebra expanding backwards in the form of a wing.

24. *Processi spinosi* of vertebrae shorter.

25. If we draw on pelvis on the upper border of ilium crest, a line parallel to base of pelvis, the upper corner of *crista ischio pubica* will remain much below this line.

16. Foramen magnum of a somewhat circular form.

17. *Processus zygomaticus* of *tympanicum* curved inwards, does not even reach the half of length of orbit.

18. Back corner of inner branch of *tympanicum* forms a blunt angle.

19. Back branch of *tympanicum* shorter, consequently the line joining the articulation of jaws just meets the back border of *condylus*.

20. If we join by a line the posterior corners of inner branch of *tympanicum* this line just touches the upper border of *foramen magnum*.

21. *Diapophysis* of second vertebra cylindrical, towards middle of outer side we notice a slight protuberance.

22. Outer side of *diapophysis* simply flattened.

23. *Diapophysis* of eighth vertebra of a cylindrical form.

24. *Processi spinosi* of vertebrae shorter.

25. If we draw on pelvis on the upper ridge of ilium crest, a line parallel to base of pelvis, the upper corner of *crista ischio pubica* will remain much below this line.

If we look back on the above tables as well as on the osteological characteristics and description of the Chinese frog we shall find that, owing to all its distinctive features *R. chinensis* can be placed near to *R. ridibunda* Pall, and that neither *R. esculenta* nor *var. lessonæ* seems designated for a closer comparison with it.

Up to now, the glandular folds on the back were alone considered as easily distinguishable characteristic marks; I find, however, that the most important amongst the outer distinctive features are: the general shape of the head, color of vocal sacs, shape of spots on the back and, finally, the formation of inner meta-tarsal tubercle. The head is comparatively very narrow and the snout ends in a very marked point.

My experience is that we never meet with *R. esculenta* having a similarly narrow head or pointed snout. Needless to say that in that respect the Chinese frog differs still more from *Rana ridibunda*. The vocal sacs are of a dusky grey and in that feature it quite resembles *R. ridibunda*.

As regards the spots on the back it differs very markedly from *esculenta*, as already mentioned the spots on the back—on some of the specimens from China—broaden in horizontal direction, giving the back the appearance of being horizontally striped. On other specimens from China the spots are entirely similar in form and disposition, to those of our *esculenta*. The spots on the specimens from Japan present quite a different shape, extending, generally lengthwise on the back, the cross-bars dividing into spots on thigh and tibia, in opposition to the Chinese specimens on which these cross-bars invariably form an uninterrupted dark line. The Chinese frog therefore, as regards the shape of its spots, could be said to somewhat approach the typical *R. ridibunda* in which the spots of the back frequently broaden horizontally.

Finally, I consider the most important mark to be the inner meta-tarsal tubercle—not meaning thereby its proportions as do Boulenger and his adherents—but most especially taking into consideration the differences manifested in its formation and its biological rôle. These differences separate insuperably *Rana chinensis* from the group of either *esculenta* or *ridibunda*. As I already remarked in the above description, the chief difference between the meta-tarsal tubercle of *Rana chinensis* and that of *esculenta* and

var. lessonæ, lies in the fact that it is *never parallel to the length axis of sole, but invariably closes on it at a larger or smaller angle, and that it never stands vertically on the surface of sole but always so to say leans against it.* The most striking difference, however, is—as also Wolterstorff already recorded—the fact of the meta-tarsal tubercle *not adhering to the base of thumb, being independently movable and that of a web extending between it and the thumb.* The above also justifies Osbeck's statement of the Chinese water-frog having six toes as in this case the meta-tarsal tubercle can truly be considered as a sixth toe transformed into a burrowing implement. The edge of the meta-tarsal tubercle is very sharp on the Peking and Tsingtau specimens and quite resembles the meta-tarsal tubercle of *Pelobates fuscus*. This edge is never as sharp on the Pingshiang, Kiukiang and Japan specimens.

The dimensions of the meta-tarsal tubercle frequently vary on specimens from Peking and Tsingtau; it attains the length of the thumb; on specimens collected at other places it is a good deal shorter, but it is never contained twice in the length of the thumb. As regards its rôle in biology, this peculiarity is in itself reason enough for *R. chinensis* to be separated as an independent species.

Once their pools dried up, our *esculenta* and *ridibunda* generally wander further on in search of new waters. Not so with *R. chinensis* which *burrows* itself in the ground as soon as water is wanting. Dr. Kreyenberg (17, p. 136) at Tsingtau, found frogs burrowed under the ground and he writes further on about the Chinese frog digging itself under the earth on the rice fields once the water there has dried up.

It is interesting to notice here that these frogs do not bury themselves thus in exceptional cases, but do this *regularly* with the beginning of the dry season; this being recorded from the surroundings of Peking and Tsingtau most likely happens elsewhere also and seems sufficient explanation of the fact that the meta-tarsal tubercle on the specimens from the above named places is so particularly well developed and so excellent a burrowing implement. It is not improbable that in some parts of those countries this burrowing is only exceptional (the specimens of Kiukiang and Pingshiang do not present so sharp a meta-tarsal tubercle) and it is most likely

that in some parts *R. chinensis* lives an exactly similar life to that of our *R. esculenta* (Kilung, Masempho).

In Wolterstorff's already mentioned article (17, p. 140) we read that the meta-tarsal tubercle of *ridibunda*, *esculenta*, and *var. lessonæ* stands in contrary proportion to the length of the tibia, that is to say, that the larger the meta-tarsal tubercle, the shorter the tibia and reciprocally. He explains this occurrence by the law of correlation; according to his opinion the *R. ridibunda's* leaping faculties are increased through the tibias' length, whilst those of *esculenta* and *var. lessonæ* are augmented by the larger size of the meta-tarsal tubercle. He then continues saying: "If the *R. chinensis* also belonged directly to this series of development, then—considering the size of the meta-tarsal tubercle—the tibia ought to be shorter still, yet just the contrary is stated as it is longer." Wolterstorff further remarks that when hind limbs are bent at right angles to axis of body the heels meet or even rather extend beyond each other. This is stated by Boulenger also (6).

On the specimens examined I found that the *heels never meet.* The reason of this can easily be explained by the Chinese frog's peculiar mode of life. As its burrowing faculties gave it the possibility of remaining in its accustomed place in spite of the water drying up, there was no necessity for wandering, thus its leaping faculties did not particularly develop whilst it possesses the burrowing-faculty's requisites, viz.: thickly set, strong hind limbs. I shall refer later on to the great modification, which wandering may cause in the length of the hind limbs.

After this I am not astonished, that Bedriaga's (17, p. 140) Ordos' specimen was found similar in the length of the hind limbs to *var. lessonæ* of Norfolk.

Referring to the explanation given on the skeleton's distinctive features, I must here again insist upon the fact that they are—according to my opinion—the most important, as the skeletons which I prepared all present the above mentioned characteristic marks, although they belonged to frogs originating from different places. The particularities most worthy of attention are on the skull: the position of nasals, the shape and dimensions of the zygomatic process as well as the fact of the condylus always extending beyond the line joining the articulation of the jaws, finally the shape

and position of the vomerine teeth group. The bony ridge visible on the diapophysis of the third vertebra of the vertebral column, as well as the characteristics in connection with the pelvis, are also exceedingly important marks.

I cannot, after these results, accept Wolterstorff's opinion (17, p. 139) that the Chinese frog is a now-arising, not yet fully expressed species, whose characteristics in the formation of the legs have not yet quite developed in each specimen. With regard to the metatarsal tubercle, my conviction is that it has reached its full development, but that, owing to climatic conditions and natural surroundings it varies in formation according to countries.

If we look back upon what has been said above, it becomes immediately clear to us that the Chinese frog bears the mixed characteristics of *R. ridibunda* and *R. esculenta*, and it is just this mixture of distinctive features which proves that we have to do with independent species. This is also confirmed by its geographic distribution. The Chinese frog is to be found—as is reported—from Vladivostok in the North down to Bangkok in the South, and from Japan westwards to the 105–110° eastern longitude. In opposition to this *Rana esculenta*, respectively the *var. lessonæ*, is to be found until the 30° eastern longitude, whilst *ridibunda* is met with as far as Persia. The fact of its geographic distribution being confined within such definite limits, seems to be a proof more, that *R. chinensis* belongs to an independent species as it were difficult to suppose that alone one variety of *esculenta* lived on such an immense territory, within so great a distance of the circle limiting the typical form's natural boundaries. If *R. chinensis* meets with any western species it can only be with *Rana ridibunda*. Boulenger supplies us in his work "The Tailless Batrachians of Europe," with a map (p. 263) marking the *esculenta* group's geographic distribution. Wolterstorff remarks (17, p. 142) that on this map he finds the limits of *Rana chinensis*' geographic distribution rather far extended westwards. My opinion is that the distance between these two species is not even as great as that, but that they most likely directly meet somewhere. This question could only be solved by a minute investigation in the regions of Asia Minor and Tien-san.

My studies on the Chinese frog have led me to the conclusion that it is not the Chinese frog which originates from *R. esculenta* or *R.*

ridibunda, but on the contrary both *R. esculenta* and *R. ridibunda* from *Rana chinensis*.

I wish to support this supposition by the inner meta-tarsal tubercle. As is already known the inner meta-tarsal tubercle of frogs has developed from the ancestral thumb, the former sixth toe. If during the development of the body any part of it is arrested in its growth and decays, it regenerates no more. This is the fact on which I found my explanation. In the above description I have already pointed out the fact that the meta-tarsal tubercle of the Chinese frog is truly no meta-tarsal tubercle at all, but a real finger connected by a web to the present thumb. The Chinese frog, influenced by surroundings and climatic conditions, adapted itself to the already mentioned peculiar mode of life and its ancestral thumb just only transformed itself so far as to become its burrowing implement.

In opposition to this it is quite evident that the meta-tarsal tubercle of *Rana ridibunda* and *Rana esculenta* has quite degenerated inasmuch as through adaptation to new conditions, it increases its dexterity in leaping. On account of this, therefore, it would be impossible to suppose that the Chinese frog's meta-tarsal tubercle together with the web between it and the first toe is a new acquisition.

I found on *Bufo viridis* Laur. a most convincing proof of the change in the hind limbs caused by wandering. In one of my articles (p. 166) whilst comparing the *Bufo viridis* of county Gömör (Hungary) to *Bufo viridis* of Konia (Asia Minor) I pointed out the fact of the specimens from Asia Minor having comparatively a good deal longer hind limbs than those from the county Gömör. After the publication of that article my friend Mr. D. v. Földváry who undertook a journey in Asia Minor in the year 1906, informed me having repeatedly met in the deserts with *Bufo viridis*, wandering in search of new pools after their former resorts had dried up.

It seems likely therefore, that the hind limbs of the specimens from Asia Minor were thus developed in consequence of this frequent wandering, and it is to be presumed that Hungarian specimens have shorter hind limbs, because they never wander. Taking these above facts into consideration it will seem more probable still that *Rana ridibunda* and *Rana esculenta* were derived from the Chinese frog whilst this latter was extending westwards; the in-

fluence of surroundings and climatic conditions then co-operated in the formation of the longer hind limb and with it the greater facility to leap. This opinion of mine differs very essentially from Wolterstorff's (17, p. 139) who wishes to prove by the Chinese frog's example the way in which a former leaping-frog gradually transformed itself into a burrowing-frog. He mentions as an example the *Pelobates* genus, which he believes to have originated in that same manner.

This seems refuted according to my opinion by the very fact of such frogs, as bearing the ancestral characteristic features—(as the *Pelobates* for instance)—being none of them agile leapers in opposition to the undoubtedly younger race of *Ranae fuscae,* of which every representative is most dexterous in leaping.

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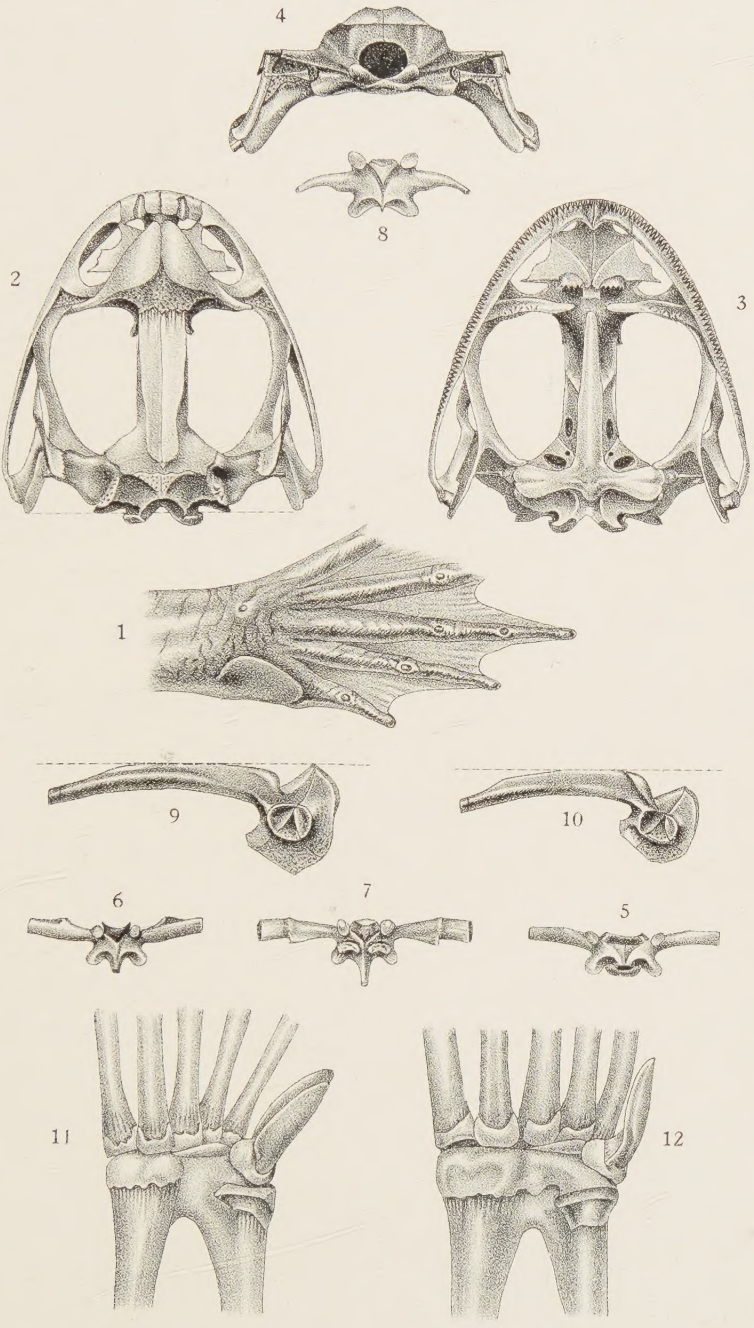
Explanation of Plate VI.

Fig. 1. First toe of hind limb, with shovel-like inner meta-tarsal tubercle. Peking. × 1.5.
Fig. 2. Skull, upper view. Kiukiang. × 1.5.
Fig. 3. Skull, under view. Kiukiang. × 1.5.
Fig. 4. Skull, back view. Kiukiang. × 1.5.
Fig. 5. Second vertebra of Rana esculenta L. upper view. Bariás, (Hungary). × 2.
Fig. 6. Second vertebra, upper view. Kiukiang. × 1.5.
Fig. 7. Third vertebra, upper view. Kiukiang. × 1.5.
Fig. 8. Eighth vertebra, upper view. Kiukiang. × 1.5.
Fig. 9. Pelvis from side. Kiukiang. Nat. Size.
Fig. 10. Pelvis of Rana esculenta L. from side. Bariás (Hungary). Nat. size.
Fig. 11. Bones of tarsus. Kiukiang. × 3.
Fig. 12. Tarsal bones of Rana esculenta L. Rimanambat. (Hungary.) × 3.



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Osteological characters of Rana chinensis and Rana esculenta.